

## 11.6 CREMATORIES

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### Process Description

Cremation is the act of reducing a corpse by burning, generally in a crematorium furnace or crematory fire. A multiple chamber incinerator is generally used to cremate human and pet animal remains. An incinerator with two chambers, namely primary and secondary, is the most widely used type of cremator. The secondary chamber is heated first by igniting the afterburner and heating to an operating temperature of at or above 1500° F. A "cremation case charge" (human or animal remains enclosed in a wooden casket/cardboard casket or a body bag) is introduced in the primary chamber, called a retort, and the retort door is closed. The charge is placed on the hearth in a manner that provides for maximum exposure to the flame of the primary burner. Control timers are set, and an opacity monitor and power switch are activated. The low fire ignition burner in the primary chamber is activated. Within approximately 30 minutes, the high fire cremation burner in the primary chamber begins a controlled cycling range of 1750 to 1800° F. This cycling continues until the cremation process is complete. During the cremation process, a large part of the body (especially the organs) and other soft tissue are vaporized and oxidized due to the heat, and the gases are discharged through the exhaust system. All that remains after cremation are dry bone fragments (mostly calcium phosphates and minor minerals). The approximate time for complete cremation is 2 hours, which may vary depending on charge weight.

After the incineration is completed, the bone fragments are swept out of the retort and the operator uses a pulverizer called a cremulator to process them into what are known as cremains which exhibit the appearance of grains of sand and recognizable chips of very dry bone.

### Completeness Determination

The following District forms should be completed and fees provided for cremators. Use the [Completeness Determination Checklist](#) to verify completeness. Use the [Data Form Guidance](#) to ensure that the forms are completed correctly. Use the [Fee Calculation Guidance](#) to ensure that the fees are calculated accurately.

1. [Form 101-B](#) (one for facility).  
Source Description: Crematory Retort with Integral Afterburner  
Process Code: 8011 (crematory retort)  
Material Code: 791 (bodies - human) and Usage Unit: tons  
or Material Code: 498 (Animal carcasses) and Usage Unit: pounds
2. [Form G](#) (one per source).  
3. [Form C](#) (one per Retort and Afterburner).
4. [Form A](#) (only if applicant chooses to control emissions with abatement equipment other than an afterburner in secondary chamber of a crematory retort).
5. [Form P](#) (one per stack).
6. If Health Risk Screening is triggered, [Form HRSA](#) (one per source).
7. Fees, calculated per [Regulation 3 \(Schedule G-1 for incinerators - crematory\)](#).
8. Any emission data available for the proposed crematory retort, or use standard emission factors indicated in Emission Calculations section.

### Emission Calculations

Crematory retort can produce emissions of flyash, smoke, gases, and odor. Odor and visible emissions can be objectionable to many people on aesthetic grounds. A poorly designed retort with inadequate turbulence, temperatures, and residence time can result in the objectionable emissions. The visible and odor emissions can best be controlled by good retort design. An afterburner in the secondary chamber of the retort compensates for deficiencies, if any, in the design of the primary chamber to minimize air contaminants.

Almost all crematory retorts use natural gas as the fuel to cremate "cremation case charge." A "cremation case charge" is a body in a casket or a bag. As a result, the emission factors available for natural gas combustion in [AP-42 Chapter 1.4 \(Tables 1.4-1 and 1.4-2\)](#) can be used to estimate particulate matter (PM10), nitrogen oxides (NOx), carbon monoxide (CO), sulfur dioxide (SO2), and precursor organic compounds (POC) emissions from the combustion of natural gas in the crematory retort. The emission factors for natural gas combustion are as follows:

### NATURAL GAS COMBUSTION EMISSION FACTORS<sup>1</sup>

Pollutant	Emission Factor (lb/MM cu ft)
PM10	7.6
NOx	100
CO	84
SO2	0.6
POC (VOC, not including methane)	5.5

In addition to natural gas combustion, there are also emissions attributed to the combustion of the casket and body. According to EPA's FIRE Program<sup>2</sup>, the PM10 emission factor associated with the combustion of body and the wrapping material is  $8.5 \times 10^{-2}$  pounds per each body burned<sup>3</sup>. In deriving the PM10 emission factor, the average weight per body incinerated was approximately 150 lbs (rounded up). In calculating the other criteria pollutants, the emission factors available for medical waste incineration in [AP-42 Chapter 2.3 \(Table 2.3-1 and 2.3-2\)](#) can be used to estimate NOx, CO, SO2, and POC emissions. In summary, the following are the emission factors for the combustion of the body and its case:

### BODY AND CASE COMBUSTION EMISSION FACTORS

Pollutant	Emission Factor (lb/ton) – used in human emissions calculation	Emission Factor (lb/body) <sup>4</sup> – used in animal emissions calculation	Reference
PM10	1.13	8.50E-02	FIRE
NOx	3.56	2.67E-01	AP-42 Table 2.3-1
CO	2.95	2.21E-01	AP-42 Table 2.3-1
SO2	2.17	1.63E-01	AP-42 Table 2.3-1
POC	2.99	2.24E-01	AP-42 Table 2.3-2

### TOXICS

For toxic emissions, emissions factors for crematories from FIRE database were also obtained:

### TOXICS EMISSION FACTORS<sup>5</sup>

Pollutant	Emission Factor (lb/body)
Acetaldehyde <sup>6</sup>	1.3 E-04
Arsenic	3.0 E-05
Antimony	3.0 E-05
Beryllium	1.4 E-06
Cadmium	1.1 E-05
Chromium, hexavalent	1.4 E-05
Copper	2.7 E-05
Formaldehyde <sup>6</sup>	3.4 E-05
Hydrogen chloride	7.2 E-02

<sup>1</sup> Emission factor is for uncontrolled natural gas boilers less than 100 MMBTU/hr.

<sup>2</sup> The [Factor Information RETrieval \(FIRE\) Data System](#) is a database containing EPA's emission estimation factors for criteria and hazardous air pollutants in an easy to use Windows program.

<sup>3</sup> Standard Classification Code (SCC) = 31502101 for Crematoriums from [Emissions Testing of a Propane Fired Incinerator at a Crematorium](#), October 29, 1992.

<sup>4</sup> The average weight of a body (including casing) is 150 lbs.

<sup>5</sup> Except for mercury, formaldehyde and acetaldehyde, pollutant emission factors are from EPA's FIRE database for crematoriums (SCC = 31502101).

<sup>6</sup> Formaldehyde and acetaldehyde emission factors are calculated based on the data in CARB's Test Report No. C-90-004, "Evaluation Test on Two Propane Fired Crematories Camellia Memorial Lawn Cemetery", October 29, 1992.

<b>Pollutant</b>	<b>Emission Factor (lb/body)</b>
Hydrogen fluoride	6.6 E-04
Lead	6.6 E-05
Mercury <sup>7</sup>	3.4 E-03 (annual average); 1.3E-02 (acute)
Nickel	3.8 E-05
Selenium	4.4 E-05
Zinc	3.5 E-04
Chlorinated dibenzodioxins and furans (expressed as 2,3,7,8 TCDD equivalents) <sup>8</sup>	1.4 E-09
Polycyclic Aromatic Hydrocarbons (PAHs) [expressed as benzo(a)pyrene equivalent] <sup>9</sup>	4.9 E-08

A [spreadsheet](#) has been developed with worksheets to calculate emissions from human and animal cremations using all the emissions indicated above.

### **Applicable Requirements**

#### District Rules and Regulations

In general, a permit is required for each crematory retort. The [cremulator](#) is exempt from permitting requirements per [Regulation 2-1-121](#).

Crematory retorts are subject to the operating standards of [Regulation 6](#) and [Regulation 8-2](#). The visible and odor emissions can best be controlled by good retort design. The permit conditions for crematories include parts which will ensure compliance with [Regulation 6](#). The permit engineer calculated emissions for POCs should be compared to the operating standards of [Regulation 8-2](#) to determine compliance.

#### Best Available Control Technology (BACT)

BACT for the crematory retorts are specified in the [BACT/TBACT Workbook](#). The following are applicable BACT requirements for:

*Crematories*  
- [Crematory](#)

Inform the [BACT Coordinator](#) of updates to the BACT/TBACT Workbook.

#### California Environmental Quality Act (CEQA)

Permit applications which are reviewed following the specific procedures, fixed standards and objective measurements set forth in this chapter (11.5) are classified as ministerial and will accordingly be exempt from CEQA review per [Regulation 2-1-311](#).

<sup>7</sup> The mercury emission factors are from “[Mercury Emissions from the Cremation of Human Remains](#)” September 24, 2012, by Jane Lundquist. This factor should only be applied for human cremations.

<sup>8</sup> Using the latest FIRE factors (dated 3/6/2008), the dioxin/furan emission factor was calculated based on the equivalency factors in the 2003 OEHHEA risk assessment guidelines (see Note 1 of attached [spreadsheet](#)).

<sup>9</sup> Using the latest FIRE factors (dated 3/6/2008), the PAH emission factor was calculated based on the equivalency factors in the 2003 OEHHEA risk assessment guidelines (see Note 2 of attached [spreadsheet](#)).

In addition to the above-mentioned source-specific applicable requirements, other requirements may also be applicable depending on the facility, its application emissions, and its source location:

- |  |  |
|--|--|
| <input type="checkbox"/> Offsets                                 | <input type="checkbox"/> School Notification     |
| <input type="checkbox"/> Prevention of Significant Deterioration | <input type="checkbox"/> Risk Screening Analysis |

**Permit Conditions**

Standardized conditions for human and animal crematories are available from the [Permit Condition Guidance](#). Refer to the [Evaluation Report Template Guidance](#) to obtain the Microsoft Word formatted permit conditions for this source category.